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ABSTRACT

This study was designed to examine the academic and attitudinal effects of a mathematics homework program on second grade children. The program was developed around mathematical games and stressed parental involvement. Data were collected through a pre/post attitudinal survey, a mathematics pre/post skills test, and a parent/student survey on the game format. The treatment occurred over an 11-week period and was analyzed by examining correlations between attitudes, parental involvement, and mathematics achievement. Responses to the instruments indicated that the parents were willing to become involved in their child's homework. Gains were registered in attitude and achievement levels. Appendices consist of the homework games and the parent and student questionnaires. (ML)

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ATTITUDINAL AND ACHIEVEMENT
EFFECTS OF MATHEMATICS HOMEWORK GAMES
ON SECOND GRADE STUDENTS AND THEIR PARENTS

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Introduction

Focus of the Study

The purpose of this study was to determine the academic and attitudinal effects of a mathematics homework program involving parents and their second-grade children. The homework program was designed around mathematical games. Student attitudes toward math as well as students' mathematical skills were assessed in relation to the program. Parent and student surveys pertaining to the homework format were examined for possible future classroom use.

Rationale for the Study

Parents have a unique privilege and responsibility. They are able to practice a fellowship with their child that others cannot experience. Along with that privilege they must also assume responsibility for their child's rearing and part of their education.

Teachers can help provide an occasion for parents to become more effective, active educators of their child through homework.

Studies have shown that parent participation and parent attitudes concerning the child's academic work

influence the child's academic achievement. For example, it had been noted in a study involving bright high school boys that if their families display positive attitudes toward schools, teachers, and academic learning, the students show greater achievement (Morrow & Wilson, 1967).

According to W. F. Johntz (1971), the disadvantaged child may fail for many reasons including a lack of needed parent help with homework that is typically offered to the middle-class child.

Homework which used a game format required a parent-partner who played an inter-active role with his/her child, whereas a typical worksheet or textbook assignment used as homework did not provide that interaction.

Games had been selected as the homework format for reasons involving student attitudes as well as parent involvement. In order to prevent possible resentment of more schoolwork I provided the homework in a style less like work and more like play and relaxation. Also, if a child had difficulty with mathematics, a negative feeling could have existed toward additional work at home. Through my years of experience as an elementary teacher I had found that games can motivate students in the classroom and, therefore, might make homework a more palatable approach to drill and reinforcement. Using

the game format for homework I expected to foster a positive attitude toward math as well as develop and reinforce math skills.

Research Method

Data were collected through a pre/post attitudinal survey, a mathematics pre/post skills test and a parent/student survey on the game homework format.

During the eleven week period students voluntarily played mathematics games with their parent/partner as homework. Acting as a resource person all materials and game explanations were provided by me.

The entire membership of the class received the treatment and analysis was done by looking at correlations between attitudes, parental involvement and mathematics achievement.

Review of the Literature

Mathematics - Need for Improved Achievement

Recently there has been much concern arising from the public and educational sectors over our schools' need to improve mathematics achievement. Both the elementary and secondary schools have shown a decline in test results (Braswell, 1985). This area needs to become a greater concern of both the elementary and secondary teachers. In the following pages I will review the literature pertaining to one method for improving mathematics achievement in the early elementary years: parental involvement in mathematics homework using a game format.

Homework

The effects of homework on achievement are unclear. Few valid studies on the effects of homework were found in the literature reviewed by Professor R. Paschal (Paschel, R., Weinstein, T. & Walberg, H., 1984). Of the fifteen valid studies Paschal located, she concluded that homework aids achievement when the teacher continues input into the completed homework. Friesen also examined research studies on homework that were done between the

years 1923 and 1976. In his survey he found that twelve experiments demonstrated positive effects of homework on achievement while eleven demonstrated no differences or negative effects on achievement (Friesen, 1978). Existing research is not clear about whether homework at an elementary level is important for effective learning (Epstein, 1983 a).

A more specific analysis of homework dealt with 319 third-grade students and their mathematics homework. Maertens (1969) found no significant differences in achievement between those students who received homework and those who did not receive homework in the low, average or high ability groups.

Homework analyses seldom include the variable of parental involvement. One study which specifically involved the parent with his/her child's homework found results in mathematics to be particularly affected for both computational and problem solving skills. (Maertens & Johnston, 1972). Since very few studies on homework included the parent/family factor, an important question pertinent to this study remains: Is homework more effective if the parent/family of the student is involved in the endeavor?

Parent Participation

Opportunities presented.

Homework presents an opportunity for parents to become involved as active educators of their children. It provides an opportunity for them to get acquainted with their child's academic talents and limitations. This opportunity of using parent resources could enhance the potential for academic gains.

Definition of parent.

For this study I will define the term parent as any family member who is responsible for the care, training and guidance of the child/student. Other family members, members of a setting in which children find themselves being reared, will also be included when referring to parent participation. Because so many children live within working and/or single parent families all family members are included in this study to assure the child/student of an active partner in his/her homework. However, for the purpose of this paper, I will refer only to the term parent.

Parent willingness to help.

In a study by Epstein, parents of elementary students surveyed reported a willingness to help 45 minutes a day with homework (Epstein, 1984). Due to teacher identification practices, students who typically

receive help from parents are often low achieving students (Epstein, 1983 b). This indicates among other things, that parental help, as a resource, has been untapped for the average and above average student.

Parent - determiner of student's success.

Granowsky, Middleton, & Mumford (1979) report on Dallas, Texas Independent School District research which showed that parents could be the strongest determiner of students' success in subjects that involved reading and computation. Therefore, a district-wide program was set up for the purpose of involving parents in their children's education. This program, referred to as "Parents in Learning," promotes a shared responsibility attitude between teacher and parent for the children's educational success. Similarly, this attitude is reflected in a Department of Education guide for parents in which involvement in homework on a regular basis through family activities is encouraged (Research Assesment, 1982).

After reviewing research reports regarding parental involvement on student achievement, Henderson (1981) concluded that parental involvement is more effective if well-planned and long-lasting. Students often show greater gains in reading when parents participate. Math gains, however, were only found in younger children. Henderson suggests that this is because parents grow

less comfortable with math than reading as their children become older and advance in school.

Problem with parent participation

Evidence shows that while parent encouragement and involvement affect student achievement in a positive way, not all parents know how to get involved or help (Epstein, 1984). In addition, some parents do not have the educational supplies at home needed to aid their child (Epstein, 1983 b). In short, we have two types of parents who can positively impact the growth of their children when assisting with homework: parents with more education who have the "know-how" and the materials to help their children, and parents who are helped to help their children (Epstein, 1984).

The parent and child have a unique relationship. Parents can capitalize on this relationship and become an effective educator of their child. However, the parent, as stated earlier, may need to become aware of teaching methods and/or may need resources to aid them in this endeavor.

Math Game Format for Homework

Games as vehicles for parent involvement.

Often the child is given an assignment from the classroom text or a written form to complete as homework.

This generally involves only the student. The parent's conventional role is to encourage his/her child to complete this home assignment. There is a need to alter this homework format so as to alter the parent's role. A game format for mathematics homework may act as a vehicle to actively involve the parent in the child's learning process at home. Games could also help provide the resource and guidance that parents may lack in order to help their child achieve in mathematics.

Games as socialization.

Children at a second grade level often need guidance in order to stay on task. Games played with peers may promote socialization but often need supervision to promote achievement. An intensive study of second- and third-grade classrooms was conducted to observe the effectiveness of games as adjuncts to reading and math instruction. Teachers used games involving reading and math skills as incentives for students to complete the assigned classroom work. It was found that students did poorly in their daily assignments when they knew they could go to a game area when their work was completed. Observers of the students recorded that they rushed to complete their work in order to join in the "fun". The games also proved to be more social than instructional

when played only with their peers. A negative relationship between achievement and the use of games as classroom incentives was shown among second grade students (Center for the Study of Evaluation, 1977).

Research on mathematical games.

Research on the effectiveness of mathematical games is sparse, and there is no conclusive evidence to suggest that mathematical games increase student achievement levels (Sovchik & Meconi, 1978). Perhaps with the addition of specific guidelines games might promote achievement through their use.

Purposes of mathematical games.

Mathematics games should promote specific skills (e.g., telling time, counting money, learning basic facts). They should be geared for several achievement purposes (e.g., concept building, maintenance of skills) in order to be most effective. Maintenance games (where children already know the fact or skill) and teaching games (where children are helped to learn the fact or skill) are different mathematics games which should be available to young students (Nelson & Whitaker, 1983).

Games can also develop reasoning skills. The process of reasoning should promote the idea that math is a way of thinking, not just a body of symbols and facts. Children need to develop clarity in their thinking

(Burns, 1984). In order to make generalizations in mathematics it is essential to recognize patterns and see relationships. Only then will the understanding of the logic in mathematics occur (Baratta-Lorton, 1976; Burns, 1984). A prediction, once a pattern is recognized, will carry over into other areas of study. Once a child senses what would happen, predictions can be tested. Number concepts must be developed through the use and manipulation of concrete materials. After this process has been completed these concepts may then be applied to computational skills using symbols rather than the concrete materials (Burns, 1984). When teaching mathematics concept building, number concepts, recognition of patterns, strategy and predictions, and reasoning one is more effective when emphasizing experiential learning-tasks. Such tasks can be presented through the use of games.

Time limitations.

Since mathematics instruction is limited to a short period of time for the lower elementary student, maintenance skills, the teaching of new skills, and concept building could be done at home within the framework of a game format in a way which would give the feeling of play to the child. A feeling of play may

be necessary to prevent the student from developing a poor attitude toward mathematics homework.

Attitudes

Promote positive attitudes.

If homework is required for mathematics, then care must be taken to promote a positive attitude toward the subject. One of the best methods to improve attitudes toward mathematics is to associate it with pleasant and interesting tasks (Aiken, 1972), such as play for the young student.

Presures affecting attitudes.

Recently we have heard and read much about "burnout". This phenomenon could possibly occur in the student who has homework at an early age. The pressures of school and additional homework could be too much (Bruno, Joseph & Burgower, 1986). Therefore, a format designed to improve mathematics achievement and maintain a feeling of play for young students should be used to avoid "burnout."

Correlation between attitudes and success.

One longitudinal study showed a positive correlation between attitudes toward mathematics and success in terms of grades (Aiken, 1970). Pleasant association with a subject should improve attitudes and promote a positive

feeling toward the subject, which in turn promotes growth in achievement. Mathematics homework within a game format can promote both.

Conclusion

Resource available to help achieve goal.

Mathematics achievement is the goal of both classroom instruction and homework. Since homework, without the aid of a parent, has not clearly shown positive results in achievement it may indeed be a waste of student time. However, studies in which parents were involved with the child and his/her homework showed results worthy of more research. Parents are willing to make this investment and appear to have positive effects on their children's achievement. Advantage should be taken of this natural resource.

Facilitating parent involvement.

In order to facilitate parent involvement in the child's homework, resources carefully planned by the teacher should be provided to the parent. These resources should include everything a parent might want or need in order to take an active role in his/her child's homework. They should also alleviate any extra stress put on the child in order to promote a positive attitude toward the subject.

Games format for homework.

Second grade children like the interaction of game playing. This pleasant activity should be put to use in a purposeful manner. Games alone will not raise mathematic achievement. However, when games are played with a parent, the child has continuous input during the process and mathematics is associated with a pleasant task. Additionally, achievement may be enhanced through this type of homework in mathematics. The following section describes one such attempt to promote a positive attitude toward and academic growth in mathematics for one group of second grade students through the use of a homework games format.

Research Report

Purpose of the Research

Due to the concern over mathematics achievement in our country a research project was established to determine the effects of mathematics homework, involving parents, on mathematics achievement and attitudes toward the subject.

As an experienced teacher I had earlier discovered that assigned homework could strain relationships between teacher and student as well as student and parent. Often children did not want to carry additional schoolwork home that was repetitive of that day's assignment. The next day the teacher felt obligated to see that students had completed the work. Parents would comment that they often had to ask their child if they had homework and had to encourage or insist that their child did it that evening. All parties involved viewed it as a burden.

Through the vehicle of mathematics games involving a partnership, parent and student, I attempted to improve the image of homework. At the same time I looked at the effects of this type of homework on attitudes toward the subject and mathematics achievement. An evaluation

of the homework format was also included for possible future use in the classroom.

Instructional Approach

Mathematics games were selected as the homework format. They were selected for the purpose of involving parent/family participation and to possibly alleviate the burden of additional "school work" for the young child. The term "games" denoted a diversionary form of mathematical skill building within a set of simple rules.

The games consisted of two designs: one was competitive in nature with a chance factor for winning (See Appendix A), and the other was a cooperative design in which partners worked together for an end result (See Appendix B). A variety of sources and formats for selection and construction of the games was used. However, all games reflected the school district's mathematics expectations for the second-grade level.

The games promoted specific skills such as learning basic facts (See Appendix C), counting money (See Appendix D), and recognition of odd and even numbers (See Appendix E). They also included mathematic concept development such as probability (See Appendix F), strategy (See Appendix G), and logical thinking (See

Appendix H). They provided skills for remediation, memorization drills for basic facts, reinforcement of current concepts taught in the classroom and enrichment for extending mathematical concepts.

Each game was placed in a large envelope with all of the necessary instructions, game board (if appropriate) and game pieces. The instruction card also indicated the mathematical purpose of the game.

As the regular classroom teacher I not only provided routine daily mathematics instruction but also became a resource person for mathematics homework.

Methods of Data Collection

Prior to the beginning of the project an attitudinal survey was administered to the twenty-five second-grade students. The survey was based on other attitudinal instruments administered within the school district. Items from those instruments were selected and/or revised to fit my needs and age level. The survey employed a "YES", "?" (I'm not sure) or "NO" response (See Appendix I). Directions needed to complete the survey were explained before it was administered. Each item was read aloud to the students.

Pre/post mathematics skills tests consisting of selected items from the Addison-Wesley Second-grade

Teacher's Resource Edition (Eicholz, 1987). The tests included items involving critical thinking (strategy, logical thinking and probability) and specific skills such as telling time and solving story problems (See Appendix J). Directions for the critical thinking section were given, by me, as suggested in the teacher guide of the textbook (See Appendix K).

A timed test measuring the student's skill in addition and subtraction facts was also given at the start of this project. The test allowed three seconds per problem and tested all of the basic facts in both areas (See Appendix L).

Facilitation of Homework

After the pre-program survey and tests had been administered, a letter was sent to parents explaining the mathematics homework. It contained a rationale for "game playing," information regarding the contents of a game packet, and the procedure for checking out new games (See Appendix M).

The following day students were able to begin checking out homework games. With each game they also took a form to be completed when returning the games (See Appendix N).

Each time the student checked out a different game he/she noted this on a classroom chart which indicated the games already played and the time spent on each game. The students had forty different games available for homework use over an eleven week period.

After the eleven week period ended the attitudinal survey and skills test were again administered to the students. Additionally, a letter (See Appendix O) explaining the completion of the games/homework program was sent to the game partners along with a survey form to be filled out by the parent/partners. This survey (See Appendix P) included items which measured attitudes about the type of homework given, the skills involved in the homework, and the relationships between partner and child during the "play of the homework.

A similar survey coinciding with the parent's survey was given to the students in the classroom using a simpler response format (See Appendix Q). Directions were explained orally and the items were read aloud to the students.

Results

It has been noted that homework should be associated with a pleasant task (Aiken, 1972) to improve attitudes

toward mathematics. The attitudinal pre/post survey helped identify progress in this area.

In evaluating the students' attitudes three categories were recognized: attitudes toward mathematics as a subject, students' own concept of self in relation to their mathematics ability, and relationships with others while involved with mathematics processes. Since the attitudinal survey was given to beginning second graders at the start of a new school year it was expected that the pre-survey would show fairly positive attitudes. Due to this expectation, when comparing pre/post surveys, an "undecided" moving to the "no" response would be considered a movement to the negative. An "undecided" response moving to the "yes" response would be considered a movement to the positive.

Table 1

Students Post Attitudinal Survey Results as Compared to Pre-Survey Results

	Attitudes toward mathematics	Students own concept of mathematics abilities	Relationships while involved with mathematics
Positive Movement	82%	60%	83%
Negative Movement	18%	40%	17%

Post survey results showed a movement of 58 responses. By looking at Table 1 it can be noted that these responses moved in a greater percentage to the positive side.

According to Aiken's longitudinal study (Aiken, 1970) a correlation should exist between positive attitudes and success in terms of grades. Therefore, let us look at the achievement scores of the students.

Due to the nature of the two tests, I have divided them into two areas for looking at the results.

Table 2

Comparison of Frequency Distribution of Pre-test and Post Test Scores of Written Test

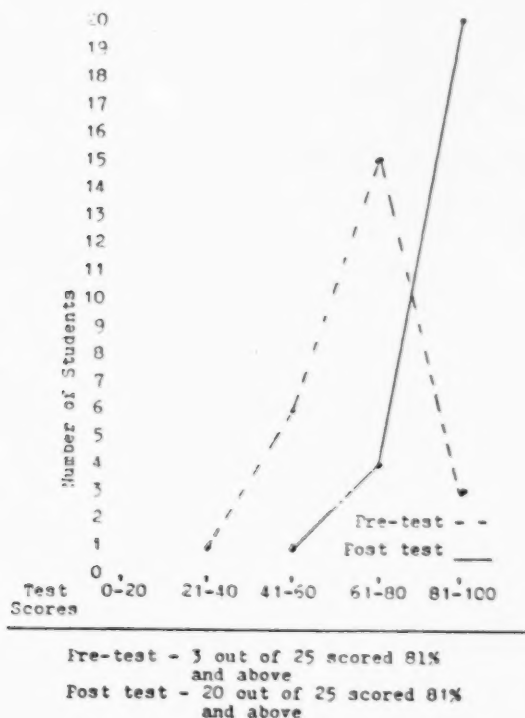
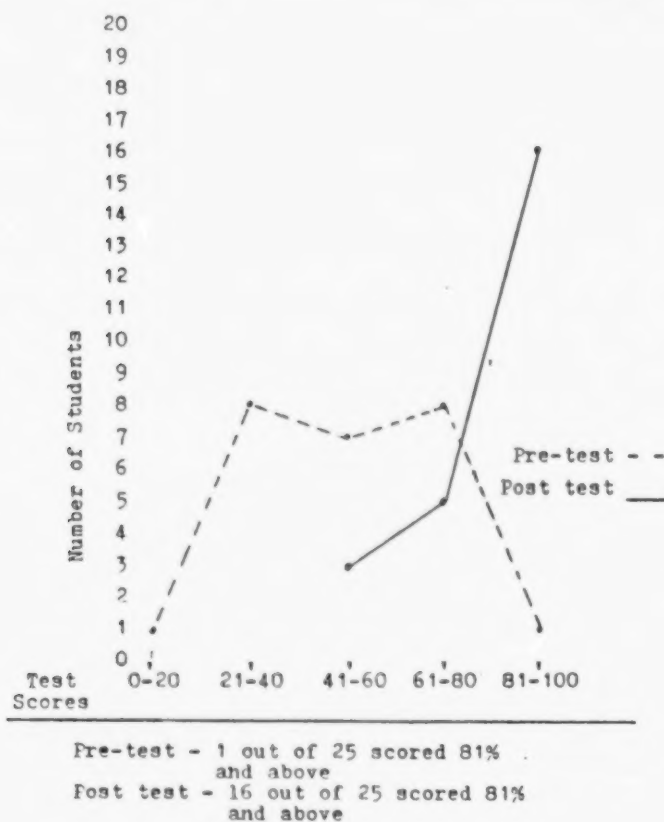


Table 3

Comparison of Frequency Distribution of Pre-test and
Post Test Scores of Basic Facts Test



When looking at the distributions of both the written test (Table 2) and basic facts test (Table 3) we see that in both areas there was a considerable gain in test results.

Also, in comparing the pre/post test scores in both tests to the class mean, 50% of the students moved closer to the class mean or above the class mean. These were generally students who performed on the lower end of the pre-test (Table 4).

Table 4

Comparisons of Student Test Results to the Class Mean

Basic Facts Test			Written Test		
Pre-test	Post Test	Gain	Pre-test	Post Test	Gain
		Loss			Loss
-32	-25	+	-9.4	-7.2	+
-29	-30	-	-4.4	-7.2	-
-22	-7	+	-4.4	-1.2	+
-22	-16	+	-4.4	+1.8	+
-16	-10	+	-3.4	-1.8	+
-15	-8	+	-3.4	-2.2	+
-13	+1	+	-1.4	-2.2	-
-13	-10	+	-.4	+1.8	+
-11	-23	-	-.4	-.2	+
-8	0	+	-.4	+1.8	+
-7	+3	+	-.4	+1.8	+
-7	+13	+	-.4	-.2	+
-4	+18	+	-.4	-2.2	-
+1	+4	+	+1.6	-.2	-
+1	+7	+	+1.6	-.2	-
+8	-20	-	+1.6	+2.8	+
+11	+9	-	+1.6	-.2	-
+12	+13	-	+2.6	+.8	-
+14	-1	-	+2.6	+1.8	-
+19	+18	-	+2.6	+1.8	-
+19	+18	-	+2.6	+1.8	-
+20	-16	-	+2.6	+2.8	+
+20	+17	-	+3.6	+2.8	-
+28	+3	-	+4.6	+2.8	-
+44	+18	-	+5.6	-1.2	-

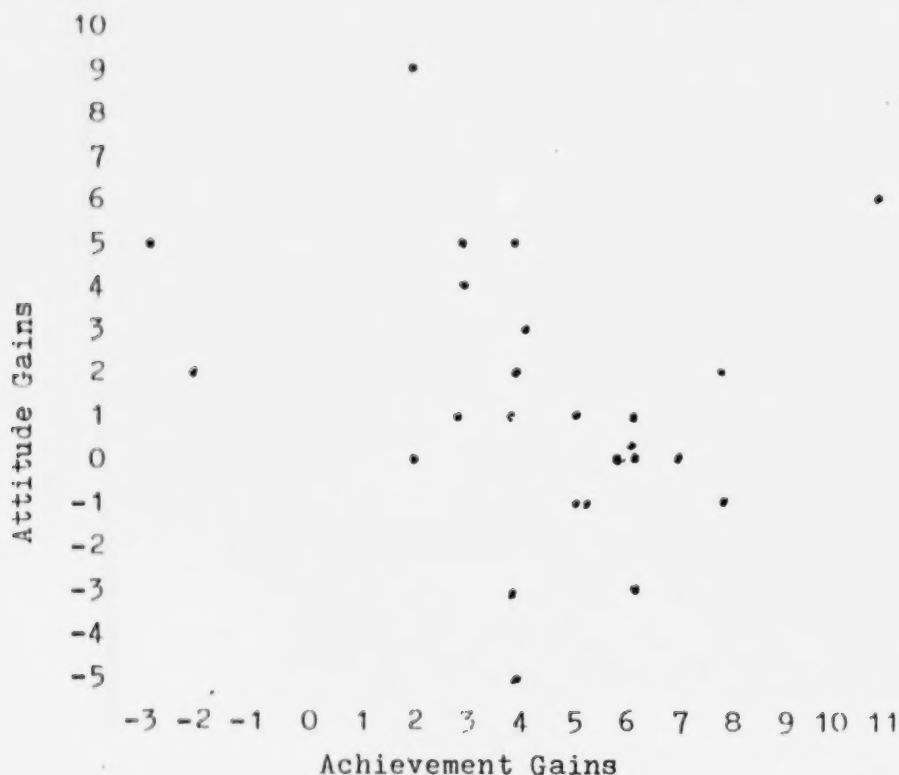
Note: 50% moved closer or
class mean

Note: 48% moved closer or
class mean

Although a gain was found in both attitudes and achievement scores a correlation between the two gains, such as Aiken's study showed, could not be found (Table 5).

Table 5

Scattergram Showing the Relationship between Attitude Gains and Achievement Gains



Since students showed achievement gains during the project it is necessary to compare these gains to the amount of participation of the students. To do this the

class was divided into thirds according to the pre-test results.

Table 6

Comparisons of Test Gains and Games Played

	Average Gains	Average Games Played
Class Mean	4.9	20
Lower 1/3	* 6.4	* 21
Middle 1/3	* 5.4	16
Upper 1/3	3.1	* 24

Note: * denotes above class mean

Table 6 indicates that those students who already do well in mathematics have a higher interest in the subject or are students who tend to take school responsibilities more seriously. Since the most active participants fell into the top third of the pre-test scores accurate results cannot be determined due to the ceiling effect.

However, since the lower third of the class showed greater participation and greater test gains as compared to the middle group, it could indicate that the games had a positive effect on test gains.

As stated earlier the most active participants fell into the upper third of the pre-test results. A brief overview of parent comments also supported this type of involvement. Parents comments about the games or their child's participation almost doubled as compared to the other two groups.

However, a general attitude of both the students and parents for the homework format from all three groups was overwhelmingly positive. It was an apparent success when students asked "Can I check out two games instead of one for the weekend?" or "If I liked this game could I check out the same one again?" With the majority of the parents, a positive response to the mathematics games was expressed to me personally. During open house, for example, parents came to meet the "game teacher." During conference time another teacher remarked "All they wanted to discuss was the math games." Furthermore, all of the mathematics students participated in the research project by checking out games on a volunteer basis.

The number of games checked out varied according to individual students, the mode being twenty out of forty available games. Students and their partners spent an average of nineteen minutes playing each game.

With student enthusiasm quite high for "game-homework" a parent asked: "My child insists that we play a game every night. Is that necessary?" Parents also commented that it was a good concept,

At times I began to wonder who benefited most from the homework. A parent wrote: "This game was a lot of fun. I played for a while then the neighbor girl played. I'm going to remember this for future use. We really enjoyed it." Therefore, I needed to take a survey of parent and student attitudes toward the homework format in order to evaluate it for future use in the classroom.

Table 7

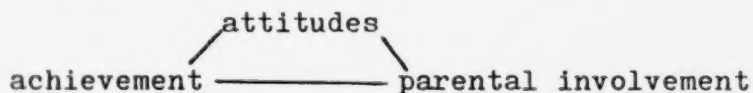
Parent/Student Survey Results - Mathematics Game Homework

	Attitudes about Games/Homework			Skills Developed during Homework			Relationships Developed during Homework Activity		
	+	?	-	+	?	-	+	?	-
Parents- 22 Responses	20	2	0	15	6	1	18	3	1
Students- 25 Responses	17	7	1	15	8	2	16	6	3

By looking at the table it is possible to recognize the wisdom reflected in the comment of one student who claimed: "I like these games, but I think my mom likes them even more than I do."

Conclusions

The major purpose of this study was to determine the effects of a more unique format for mathematics homework. It was also set up for the purpose of looking at correlations between



In agreement with Epstein (1984), a willingness of parents to become involved with their child's homework was quite evident. The child's need for parents at this age level is strong (Francke, 1985). The teacher can take advantage of these two observations. A parent commented about the game homework format: "It is a good concept of promoting both math skills and quality parent/child time - sharing."

Along with obvious parental involvement, attitude and achievement levels showed a positive gain. By looking at all three areas it could be stated that this research showed positive results. This would be an over simplification. No conclusive evidence could correlate improved attitudes to achievement scores. Parental involvement and achievement showed some correlation. However, due to the design of this research, it would be impossible to ignore other possible variables.

Variables such as: the effects of the daily classroom teaching methods, effects of the various family structures and the positive/negative interactions of the parent-partner should be considered when evaluating this research. All of these factors could be a concern for future study.

Discussion

The game format for homework became a positive experience for me as well as it did for the students and the parent/partner. Far too seldom do teachers get positive comments as incentives to continue creative and thoughtful teaching. This project provided the stimulus for future programs that may require research and additional work to make the classroom a more interesting environment for learning.

It helped point to the fact that parents involved with teachers and their children can possibly make a difference. However, the responsibility lies with the teacher to invite discussion and active involvement for all three parties.

Games, in this instance, were only a vehicle for involvement and learning. Without a map, a plan, the vehicle could not reach a specific destination. To reach that goal I, as a teacher, must provide the resources and plan for students' academic successes.

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Appendix A

Going To Boston

Two or more

To get a higher score than any other player after three throws of the dice

Three dice

HOW TO PLAY GOING TO BOSTON

1. Each player throws the dice three times in succession when it is his or her turn.
2. After each throw, the die with the highest number is the only one counted toward the score, like this:
 - a. On the first throw the player throws three dice, setting aside the die with the highest number.
 - b. On the second throw the player throws the two remaining dice and sets

aside the die with the higher number.

- c. On the third throw the player throws the last die and adds together the numbers of all three dice to get the total points for that round.
3. The only time a player does not throw the dice three times is if he or she throws doubles on the second throw. If this happens, one die is counted as the second throw and the other die is counted as the third throw.
4. There is no advantage to being the first shooter. Any player may throw first.

SAMPLE GAME

1. Player 1 throws all three dice.



The 4 is the highest number. Player 1 sets the 4 aside. On his second throw he throws two dice.



The 5 is the higher number and is set aside. On his third throw he throws one die.



A 6 is thrown. Now Player 1 adds the numbers of all three dice.

$4 + 5 + 6 = 15$ points for that round

2. Player 2 throws all three dice.



The 4 is the highest number and is set aside. On her second throw she throws two dice.



Player 2 throws doubles (two 6's). Doubles on the second throw means that one die counts for the second throw, the other die for the third throw.

Player 2's turn ends. Now Player 2 adds the numbers of all three dice:

$4 + 6 + 6 = 16$ points for that round

Materials: dice

Source: (Belton, 1976)

Appendix B

Problem Situation

Trains of Eight - Number Sums

Build all the different trains that you can using the two different colored cubes. Each train will be eight cubes long.

On the paper list all the facts you can that are sums of eight. Let the trains of cubes help you.

Example: $1+7=8$, $2+6=8$, etc.

Note: Students should do the manipulative example first. This may seem simple but is necessary for concept building.

Materials: two colored cubes (eight of each)

Source: (Burns, 1984)

Appendix C

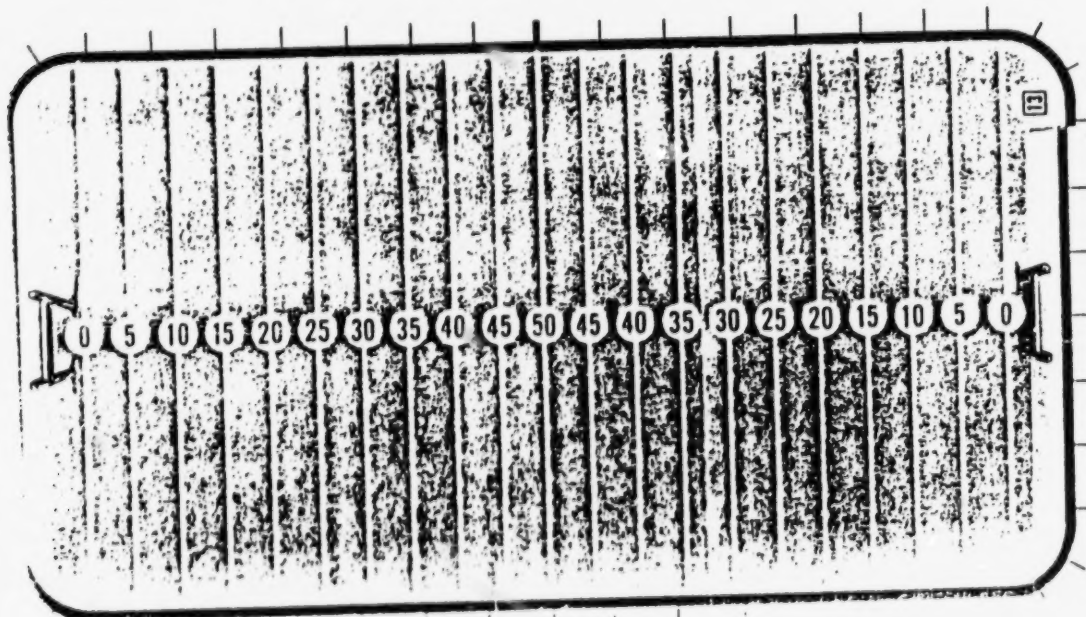
Basic Facts - Subtraction

Touchdown

Place the board so that each player faces a goal. Place the football (marker) in the center on the 50-yard line. Players take turns throwing the dice and moving the difference between the numbers shown on the dice. If the first player rolls a 6 and 4, he would move the football two spaces, or 10 yards, toward the opponent's goal. The second player moves the football the opposite direction.

Materials: gameboard (reduced example below), markers, dice

Source: (Whitman, 1961)

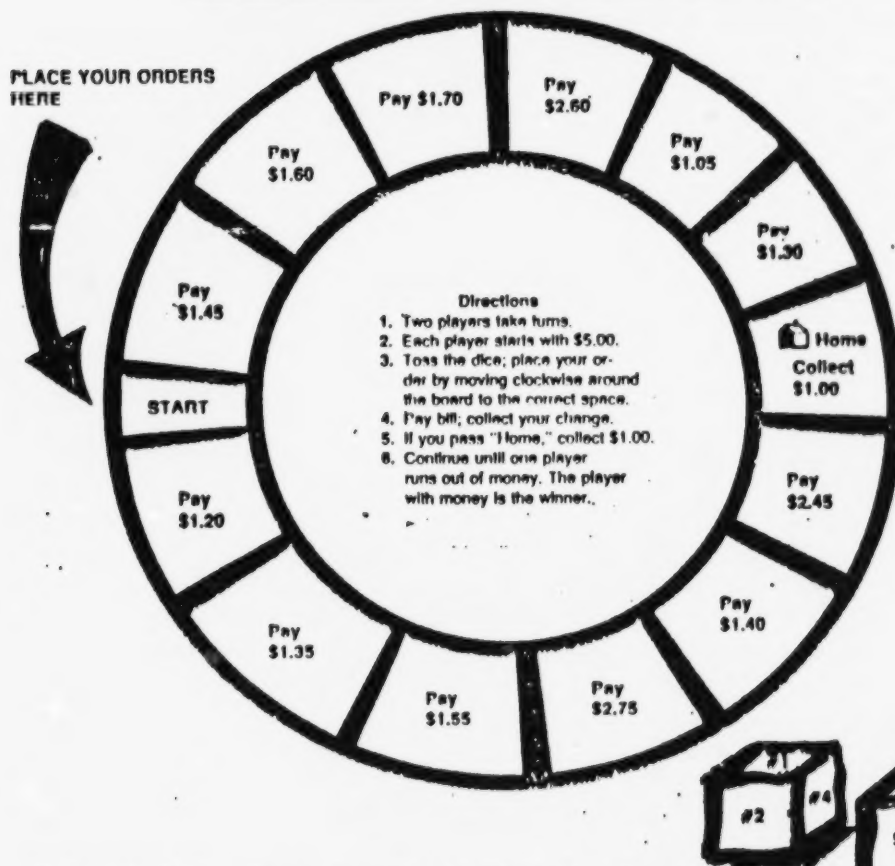


Appendix D

Money

Time Out for Lunch

SANDWICHES		DRINKS	
#1	Hot Dog.....	\$0.70	Small.....\$0.35
#2	Hamburger.....	\$0.95	Medium.....\$0.50
#3	Cheeseburger.....	\$1.05	Large.....\$0.65
#4	Fried chicken.....	\$2.10	



Materials: Game board (reduced above), play money, dice, markers

Source: (Fennel, 1981)

Appendix E

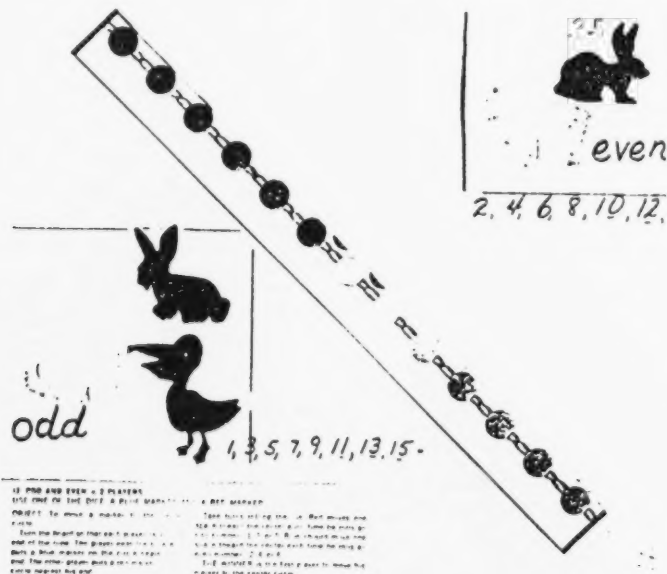
Odd, Even Numbers

Odd and Even - 2 players

Turn the board so that each player faces one end of the rope. The player near the blue end puts a blue marker on the circle nearest his end. The other player puts a red marker on the circle nearest his end. Take turns rolling the die. Red moves one space toward the center each time he rolls an odd number - 1, 3, or 5. Blue should move one space toward the center each time he rolls an even number 2, 4, 6. The winner is the first player to move his marker to the center circle.

Materials: dice, blue marker, red marker, gameboard
(reduced below)

Source: (Whitman, 1961)



Appendix F

Probability

Spill the Beans

If you spill the beans and record how many painted sides come up each time what do you think the results will be? Try it. Spill the beans at least 25 times.

Record your results.

Note: Children must sense what should happen in mathematical situations. This game will also encourage the recording of results.

Materials: painted beans (6)

Source: (Burns, 1984)

Appendix G

Strategy using Greater Than, Less Than, Equal To

Rollo

Roll the two dice, one a regular die and the other a

< > = symbol die.

If you roll the symbol < and the number 3, place a chip of your color in a number or a pattern less than 3.

The first player who covers a row, column or diagonal wins.

Note: The > symbol is greater than. The < symbol is less than. The = symbol signifies equal to.

Materials: two dice, chips (two colors), gameboard

Source: (Racine Unified School District 1979)

five	3 + 1	II	3	0	3 + 3
	7 - 1	six	8 - 4		6 - 4
4 + 2	1 + 0	4	2 - 1	III	1
5 - 5	1	2	6 + 1	5 - 2	4 - 2
four			4 + 1	6 + 1	5
2 + 3	7	1 + 1		6	2

Appendix H

Logical Thinking

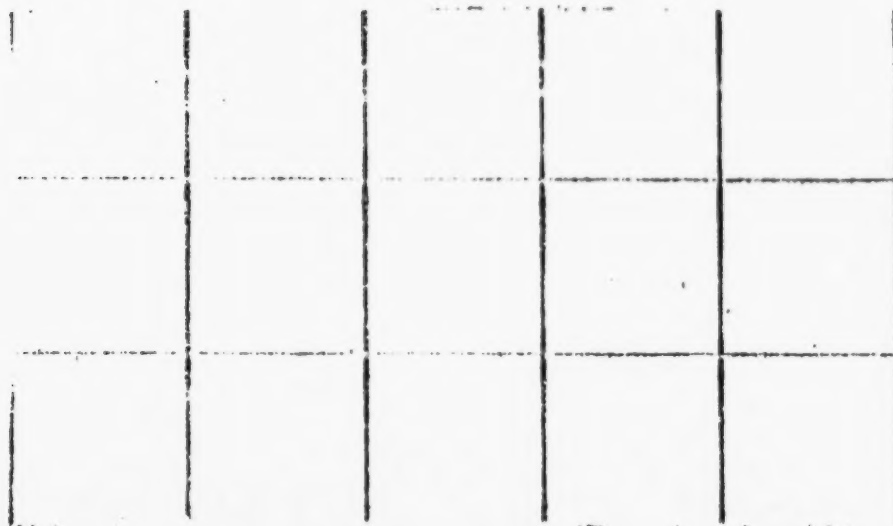
Color In

On your turn, color in 1 square or 2 squares with a common side. Whomever colors in the last square wins.

Note: In order to be the last person to color in a square logical thinking, along with strategy, must be used.

Materials: squared paper (example below)

Source: (Burns, 1984)



Appendix I

Name _____

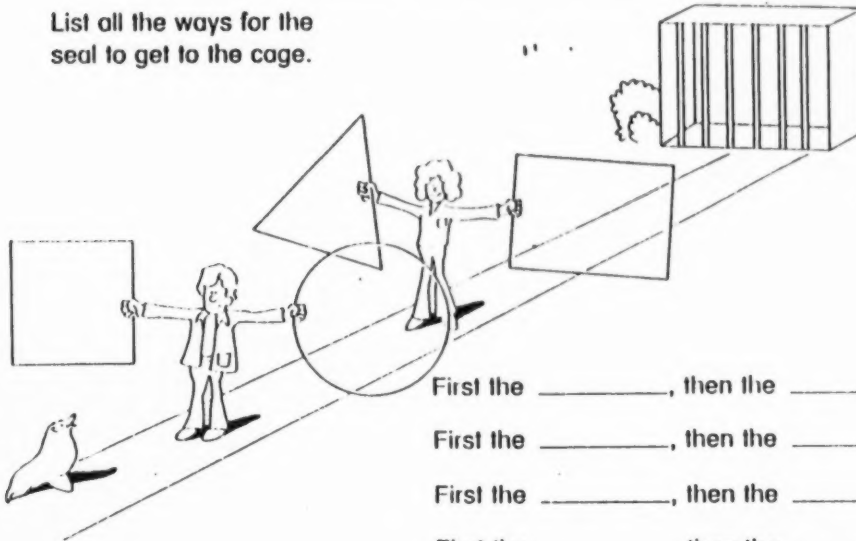
1. I'm proud of my math work.
yes ? no
2. I feel left out of things in math class.
yes ? no
3. I give up easily when I don't understand math.
yes ? no
4. I'm good at working math problems.
yes ? no
5. I think I do poorly on math tests.
yes ? no
6. I worry a lot during math class.
yes ? no
7. I am smart in math.
yes ? no
8. I find it hard to talk in front of others in math class.
yes ? no
9. I give up when the problems are too hard.
yes ? no
10. I would be happier if I didn't have to do math.
yes ? no
11. I like to do math homework.
yes ? no
12. Math is boring.
yes ? no
13. I like to do math in school.
yes ? no
14. I wish I had a longer math class.
yes ? no
15. When I am doing my math work other children bother me.
yes ? no

Appendix J

Name _____

List all the ways for the seal to get to the cage.

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First the _____, then the _____

First the _____, then the _____

First the _____, then the _____

First the _____, then the _____

4. How much do 4 whistles cost?



Number of Whistles	1	2	3	4
Cost	 3¢	 6¢	 _____¢	_____¢

4 whistles cost _____¢.

5. How much do 5 stickers cost?



Stickers
5¢ each

Number of Stickers	1	2	3	4	5
Cost	5¢	10¢	15¢	_____¢	_____¢

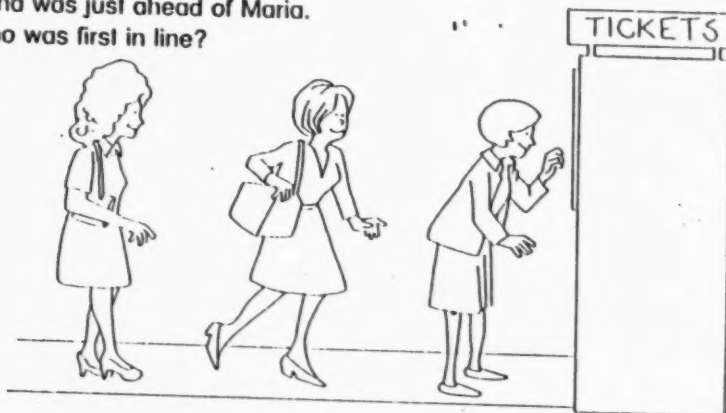
5 stickers cost _____¢.

6. Bob is the tallest.
Charlie is taller than Randy.
Who is the shortest?



_____ is the shortest.

7. Sue was last in line.
Dana was just ahead of Maria.
Who was first in line?



_____ was first in line.

8. Which is Amy's favorite number?

It is greater than 2.

It is less than 5.

You say it when you count by 2s.

Amy's favorite number is _____.

1

2

3

4

5

6

9. How old is Drew?

He is older than 5.

He is younger than 11.

You do not say his age when
you count by 2s.

You do not say it when you
count by 3s.

Drew is _____ years old.

5?

6?

7?

8?

9?

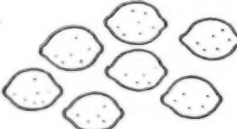
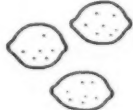
10?

11?

12?

Solve.

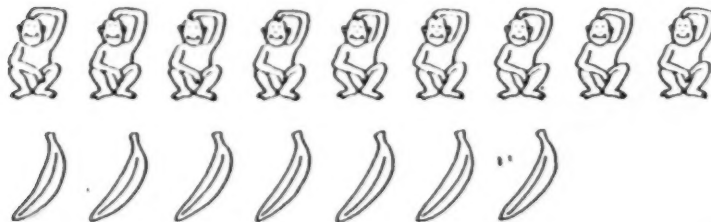
1. Doug has 5 buttons.  (A) 8
 Ann has 3 buttons.  (B) 2
(C) 9
 How many buttons do they have in all?

2. Marla had 10 lemons.  (A) 13
 She gave 3 away.  (B) 7
(C) 6
 How many lemons does she have left?

3. Pam had 7 records.  (A) 9
 She broke 2.  (B) 5
(C) 7
 How many records does she have now?

4.

How many more monkeys
than bananas are there? _____



5. 17 plums grew on a tree.
Birds ate 8.
How many plums were left? _____



plum

Give the time.

1.



2.



3.



_____ minutes

_____ minutes

_____ o'clock

after _____ o'clock

after _____ o'clock

Ring the time that matches the clock.

4.



3:10

5.



12:30

6.



3:45

10:15

1:30

2:45

3:50

6:05

9:10

7. Ring the time that is
2 hours later.



3:00

5:00

9:00

8. How many
Mondays are
in this month?

NOVEMBER						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Appendix K

Directions and Solutions

PAGE 281 MAKE A LIST (for use after text page 60)

1. Begin by having students color the four roads, each a different color. Then read the direction line at the top of the page. Tell the students to write their answers in the spaces provided.

Solution (Colors and order may vary.)

Red road, then yellow road
Red road, then green road
Blue road, then yellow road
Blue road, then green road

2. Begin by explaining that the seal has to jump through two hoops to get to its cage. Point out the two people holding hoops and have children name the shapes of the hoops. You may need to write the names of the shapes on the chalkboard for students to copy. Explain that the seal first has to jump through either the rectangle or the circle, and then through either the triangle or the square. Tell students to write their answers in the spaces provided.

Solution (Order of answers may vary.)

First the square, then the triangle
First the square, then the rectangle
First the circle, then the triangle
First the circle, then the rectangle

PAGE 282 GUESS AND CHECK

(for use after text page 120)

1. Begin by discussing a dart game and how points are scored. Have students read aloud the numbers on the dart board. Then read the problems at the top of the page. Tell students to write the numbers in the space provided.

Solution $9 + 2 = 11$

2. Have the students read the numbers on this dart board. Then read the problem on the page. Tell students to write their answer in the space provided.

Solution $8 + 4 = 12$

PAGE 283 FIND A PATTERN

(for use after text page 174)

1. Begin by discussing model trains and how toy stores sell single train cars as well as sets. Read the direction lines at the top of the page. Tell the students to write their answers in the spaces provided.

Solution 10¢, 20¢, 30¢, 40¢, 50¢

Pattern: The prices increase by 10¢.

2. Tell students that a certain store has 5 sizes of animal erasers. Have students read the sizes of the erasers shown on the boxes. Read the direction lines and tell students to write their answers in the spaces provided on the boxes.

Solution 3¢, 5¢, 7¢, 9¢, 11¢

Pattern: The prices increase by 2¢.

PAGE 284 MAKE A TABLE (for use after text page 220)

1. Begin by drawing attention to the picture of the whistle at the top of the page. Have students read aloud the cost of 1 whistle. Read the question at the top of the page. Tell students to draw pennies and write prices in the table to help them answer the question.

Solution

Number of Whistles	1	2	3	4
Cost	3¢	6¢	9¢	12¢

4 whistles cost 12¢.

2. Begin by discussing the cost of 1 sticker. Read the question and tell students to use the table to help them answer the question.

Solution

Number of Stickers	1	2	3	4	5
Cost	5¢	10¢	15¢	20¢	25¢

5 stickers cost 25¢.

PAGE 285 USE A PICTURE (for use after text page 264)

1. Begin by telling students they can use the pictures given to help them solve the problem. Read the problem at the top of the page. Tell students to write the names of the boys in the spaces provided below the pictures.

Solution



Randy

Charlie

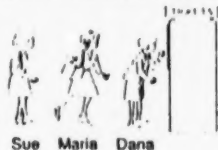
Bob

Randy is the shortest.

Directions and Solutions

2. Read the problem. Tell students to use the pictures given to help them solve the problem, and to write the names of the girls in the spaces provided below the pictures.

Solution



Sue Maria Dana

Dana was first in line.

PAGE 286 LOGICAL REASONING

(for use after text page 308)

1. Begin by having students read the numbers given on the cards. Read the question at the top of the page. Tell students to read the clues and to use them to decide which number is Amy's favorite.

Solution Numbers greater than 2 and less than 5 are 3 and 4. Since you say the number when you count by 2s, the answer is 4. Amy's favorite number is 4.

2. Begin by having students read the numbers given on the page. Tell students to read the clues given and use them to find Drew's age.

Solution Numbers greater than 5 and less than 11 are 6, 7, 8, 9, and 10. You say 6, 8, and 10 when you count by 2s. You say 6 and 9 when you count by 3s. Drew is 7 years old.

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Appendix L

ADD

<u>0</u> 3	<u>2</u> 4	<u>3</u> 2	<u>8</u> 1	<u>3</u> 5	<u>9</u> 9	<u>2</u> 9	<u>9</u> 8	<u>8</u> 6	<u>7</u> 5
<u>1</u> 1	<u>1</u> 4	<u>0</u> 7	<u>2</u> 6	<u>6</u> 3	<u>4</u> 9	<u>5</u> 8	<u>9</u> 6	<u>0</u> 5	<u>9</u> 3
<u>2</u> 1	<u>0</u> 1	<u>4</u> 1	<u>3</u> 3	<u>4</u> 5	<u>8</u> 8	<u>8</u> 7	<u>9</u> 5	<u>7</u> 4	<u>8</u> 9
<u>0</u> 4	<u>2</u> 5	<u>1</u> 7	<u>4</u> 2	<u>5</u> 3	<u>2</u> 8	<u>3</u> 8	<u>8</u> 4	<u>8</u> 2	<u>7</u> 8
<u>1</u> 2	<u>0</u> 2	<u>0</u> 8	<u>3</u> 4	<u>3</u> 6	<u>4</u> 7	<u>6</u> 6	<u>9</u> 2	<u>3</u> 9	<u>9</u> 4
<u>2</u> 2	<u>1</u> 5	<u>6</u> 1	<u>5</u> 2	<u>5</u> 4	<u>5</u> 6	<u>6</u> 5	<u>6</u> 9	<u>6</u> 8	<u>7</u> 6
<u>0</u> 5	<u>3</u> 1	<u>0</u> 9	<u>1</u> 8	<u>7</u> 2	<u>5</u> 5	<u>6</u> 4	<u>1</u> 9	<u>6</u> 7	<u>8</u> 3
<u>1</u> 3	<u>0</u> 6	<u>5</u> 1	<u>6</u> 2	<u>4</u> 4	<u>8</u> 3	<u>9</u> 1	<u>4</u> 8	<u>3</u> 7	<u>9</u> 7
<u>2</u> 3	<u>1</u> 6	<u>7</u> 1	<u>2</u> 7	<u>4</u> 3	<u>7</u> 2	<u>5</u> 2	<u>7</u> 7	<u>4</u> 6	<u>5</u> 7

Appendix M

September 22, 1986

Dear Parents,

Much of our math, up to this point, has been a review of skills already learned. These skills will constantly be reviewed and refined. Memorization of addition and subtraction facts is a necessity in order for your child to be successful in math. Please devote five minutes every night to this skill. If you need flashcards please let me know. I will help make some for home purposes.

Tuesday, your child will bring a homework packet home. The homework will involve math skills that are necessary to promote mathematical concepts. It will involve you or another member of the family. The packet will consist of a direction card and the necessary materials needed for mathematical "game playing". Many of these games may seem unrelated to math skills. However, they will help build strategy, probability, charting or memorization skills. Children often need experiences with a hands-on technique in order to foresee the necessary steps for problem solving.

A form will accompany the "game". Please fill it in when returning the packet.

The game may be kept as long as you feel your child can benefit from it. Once it is returned a new game will be sent home.

A "game playing" chart will be kept in the classroom. The chart will show the amount of time spent on each game at home. Therefore, if you are unable to play the game with him/her please encourage another member of your family to do so.

Thank you for your help.

Sincerely,

Mrs. Mucha

Mrs. Mucha

Appendix N

Name _____

Game number and letter _____

Time spent playing: the game to the nearest 5 minutes _____

Signature of game partner _____

Please feel free to comment on the game and/or your child's needs or strengths.

Note: If directions are unclear please comment.

Appendix O

December 11, 1986

Dear Game Partners,

Thank you for your active participation in your child's math homework. Your time and effort have been appreciated.

Realizing it is a busy time of year, this type of homework will be discontinued at this time.

I would appreciate your opinions to help evaluate the worth of mathematic games as homework. You will also help decide if the math games should continue at a later date. If the results are positive only one game a week would be available for homework use.

Two copies have been enclosed. This will allow for two members of the family/game partners to voice differing opinions or comments.

Again, thank you for your time.

Sincerely,

Mrs. Mucha

Mrs. Mucha

Appendix P

Mathematics Homework Games

Please circle your response for each question and feel free to comment.

5 = Strongly Agree

4 = Agree

3 = Undecided

2 = Disagree

1 = Strongly Disagree

1. My child usually enjoyed this type of homework.

Diagram of a horizontal beam with a uniformly distributed load. The beam is labeled SA at the left end and SD at the right end. Above the beam, the numbers 5, 4, 3, 2, and 1 are placed at regular intervals, representing the load intensity in kN/m.

• Comment: _____

2. My child improved his/her math skills by using the math games.

$$\begin{array}{ccccccc} 5 & & 4 & & 3 & & 2 & & 1 \\ SA & \text{-----} & & & & & & & SD \end{array}$$

Comment: _____

3. My child usually learned math skills or concepts during the play of these math skills.

$$\begin{array}{ccccccc} 5 & & 4 & & 3 & & 2 & & 1 \\ SA & \text{-----} & & & & & & & SD \end{array}$$

Comment: _____

4. The math games usually made me more aware of my child's math strengths or weaknesses.

5	4	3	2	1
SA				SD

Comment: _____

5. I was usually able to help clear up any misunderstanding of math concepts during the math games.

5	4	3	2	1
SA				SD

Comment: _____

6. One of the values of the math games was the time spent with my child.

5	4	3	2	1
SA				SD

Comment: _____

7. The primary value of the math games was to keep my child busy.

5	4	3	2	1
SA				SD

Comment: _____

8. I would like to see the math games continued - other than on a daily basis.

5	4	3	2	1
SA				SD

Comment: _____

9. My child would like the math games to continue -
other than on a daily basis.

5	4	3	2	1
SA			SD	

Comment: _____

Many of you commented on specific games as they were returned. If you have any general comments about the strengths or weaknesses of the games please feel free to do so.

Comment: _____

Appendix Q

Mathematics Homework Games

1. I enjoyed this type of homework.
yes ? no
2. I improved my math skills by using the math games.
yes ? no
3. I usually learned some math skills while I played the math games.
yes ? no
4. While playing the games I knew I was good at some of the math.
yes ? no
5. While playing the games I knew that I should study math more at school and at home.
yes ? no
6. My partner helped me if I didn't understand the math problems when I was playing the game.
yes ? no
7. I enjoyed doing my math with someone from my family.
yes ? no
8. My parents would like me to keep bringing home the math games - once a week.
yes ? no
9. I would like to keep taking home the math games - once a week.
yes ? no